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Patentanmeldung Nr.   **Patent application No.**   **Demande de brevet n°**

02076369.4

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R C van Dijk

Anmeldung Nr:
Application no.: 02076369.4

Demande no:

Anmeldetag:
Date of filing: 05.04.02
Date de dépôt:

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Method to control a process

In Anspruch genommene Prioriät(en) / Priority(ies) claimed /Priorité(s)
revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

G05B19/00

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of
filing/Etats contractants désignées lors du dépôt:

AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

METHOD TO CONTROL A PROCESS

The invention is directed to a method to control a
process, wherein the status of the process can be altered
by a multitude of actions, wherein the action is
controlled by basic control units, wherein a basic

5   control unit is coordinated by a group control unit.

Such process control schemes are known and for
example described in Ullmann's Encyclopedia of Industrial
Chemistry, Vol. B6, pages 416-427.

A problem with such control schemes is that when

10   applied for processes, which inherently have a risk of
failure, and which require high safety measures a
complicated safeguarding and control scheme is required.
Such processes are generally controlled by process
control schemes comprising more than one group control

15   unit, each of which may have safeguarding measures
according a certain -often extensive- decision tree for
corrective actions that may be directed to the same
action or conflicting actions depending the
circumstances. Complicated control schemes result.

20   Furthermore debugging and maintenance of such a system is
found to be very laborious. For example a minor process
adjustment or omission of a relevant failure mechanism
may require a complete overhaul of the control scheme
with its decision tree and corrective actions.

25   The object of the present invention is to provide a
method to control a process, which does not have the
above disadvantage.

This object is achieved with the following method.
Method to control a process, wherein the status of the
process can be altered by a multitude of actions, wherein
the action is controlled by basic control units, wherein
at least one basic control unit is coordinated by a group
control unit and wherein this basic control unit
comprises the following functions:
(b1) means to receive and priority handle a request for a
basic control action from one or more group control units
or from the operator to be performed by said basic
control unit, (b2) means to receive and transform
information from the process and/or output from basic
control unit(s) and/or output from group control unit(s)
into a permit required to start or to continue to execute
said action, (b3) means to receive lockouts from basic
control unit(s) and/or from group control unit(s) and/or
from the operator and/or from the basic control unit
itself to prevent the start or to initiate the
termination of said action and force the default status
or shut-down sequence of the basic control unit until the
received lockout(s) has (have) been removed and also a
reset has been activated, (b4) means to process an
internal lockout and/or export an output or lockout,
which output/lockout is related to the status of said
action and (b5) means to execute said required action
according to a logic or sequence according to which the
basic control unit operates,
and wherein at least one of these group control unit
comprises the following functions:
(g1) means to receive and priority handle a request for a
group control action from an even higher hierarchy
control unit or from the operator to be performed by said
group control unit, (g2) means to receive and transform

information from the process and/or from basic control unit(s) and/or from group control unit(s) into a permit required to start or to continue to execute said group action, (g3) means to receive lockouts from basic control unit(s) and/or from group control unit(s) and/or from the operator and/or from the group control unit itself to prevent the start or to initiate the termination of said action and force the default status or shut-down sequence of the group control unit until the received lockout(s) has (have) been removed and also a reset has been activated, (g4) means to process an internal lockout and/or export an output or lockout, which output/lockout is related to the status of said group action and (g5) means to execute said required group action according to a logic or sequence according to which the group control unit operates.

Because both group control units and basic control units have the same basic functionality throughout the whole of the process control scheme becomes transparent for the user.

Because the basic control units have a certain minimum decision tree for corrective actions the group control unit has a much simpler decision tree for corrective actions, can handle much more functions, and has an easier to alter control scheme. Suitably one group control unit coordinates more than one basic control unit. The method to control a process according to the present invention is advantageously used in a process wherein at least one basic control unit is coordinated by at least two different group control units.

The above control scheme is suitably used to control processes with a potentially high risk of hazards. Examples of such processes are gasification processes

wherein synthesis gas is prepared by partial oxidation of
a solid, liquid or gaseous (hydro)carbon containing feed.
In such processes a feed is partially oxidised in the
presence of (pure) oxygen -which on itself contributes to
a potential risk- to prepare a highly reactive product,
namely a mixture of carbon monoxide and hydrogen. Thus it
will be clear that in such processes the conditions
during feeding of the oxygen and during gasification and
the start-up and shut down sequence are carefully
controlled in order to avoid for example oxygen fires as
well as full oxidation of the feed, release of the
product to the environment or over heating of equipment.

The invention shall be illustrated by making use of
Figures 1-3. Figure 1 is a simplified process scheme of a
gasification reactor and relevant feed lines and valves.

Figure 2 is a scheme illustrating the logic as part
of a basic control unit.

Figure 3 is an illustration of how one group control
unit controls four basic control units in a gasification
process of Figure 1.

To burner 1 of reactor 2 in Figure 1 a feed line 3
for oxygen and a feed line 4 for natural gas is
connected. On oxygen feed line 3 means 5 to purge or
route oxygen to the atmosphere is present. This purge
action is controlled by basic control A operating valves
A-1 and A-2. To feed line 3 also means 6 to replace
oxygen by high-pressure steam, means 7 to replace oxygen
by nitrogen and means 8 to replace oxygen by air are
present. The action of supplying or not supplying these
gasses are controlled by respectively basic control B,
basic control C and basic control D, which in turn
operate as an action so-called Double Block and Bleed
B-1, C-1, and D-1.

On feed line 4 means 9 to purge or route natural gas
to a safe location is present. Basic control E operating
valves E-1 and E-2 control this purge action. To feed
line 4 also means 10 to add high-pressure steam to the
5   natural gas and means 11 to replace natural gas by
nitrogen are present. The action of adding or not adding
these gasses are controlled by respectively basic control
F and basic control G, which in turn operate as an action
Double Block Bleed F-1 and G-1.

10   Basic controls A-G are in turn controlled by more
than one group control units (not shown in Figure 1).

In addition to the above feeds a gasification process
may also suitably comprise similar control units for the
following process streams: natural gas and air to the
15   auxiliary burner used for reactor pre-heating prior to
the start of the gasification, water feed to the waste
heat boiler (synthesis gas cooling against steam
production in unit downstream of the reactor 2), water
feed for cooling the burner 1, vent to heat up stack,
20   synthesis gas routing to the flare or the scrubber, and
steam production in the waste heat boiler.

Figure 2 shows a more detailed description of basic
control C of Figure 1. Basic control C has (b1) means to
receive and priority handle a request for a basic control
25   action from one or more group control units or from the
operator to be performed by said basic control unit.
Possible actions which are suitably controlled by the
basic control unit are controlling a Single Block (closed
bleed), or sequence controlling Double Block and Bleed
30   (DBB) (none, standby or run), and/or enabling/disabling
control valves for Distributed Control System (DCS)
functions (not shown). The valve arrangement C-1, which
is controlled by basic control C intends to stop/separate

the nitrogen from the process at the absence of any
manual or remote request, intends to prepare the nitrogen
up to the last block (XV-163) at "manual standby" request
only, and intends to have flow of the nitrogen to the
5   process at "run" request, either by manual or remote
request and regardless of "standby" request. When used in
a certain sequence the manual "close bleed" request and
the other manual requests are useful in verifying valve
leakage rates (which is a safety issue). Obviously for
10   this latter use additional instrumentation (not shown)
will be present.

The basic control unit C will also comprise (b2)
means to receive and transform information from the
process and/or output from basic control unit(s) and/or
15   output from group control unit(s) into a permit required
to start or to continue to execute said action. For
example basic control unit C will not supply nitrogen to
the process when the gasification is ongoing, or when the
nitrogen pressure is too high (PZH-106) or to low
20   (PZL-160) or the pressure differential across certain
valves and orifice (PDZL-162) is not positive enough. The
basic control unit C may also comprise (b3) means to
receive lockouts from basic control unit(s) (not shown)
and/or from group control unit(s) (not shown) and/or from
25   the operator (shown) and/or from the basic control unit
itself (not shown) to prevent the start or to initiate
the termination of said action and force the default
status or shut-down sequence of the basic control unit
until the received lockout(s) has (have) been removed and
30   also a "reset" has been activated. The basic control
unit C will also comprise (b4) means to process an
internal lockout and/or export an output or lockout,
which output/lockout is related to the status of said

action. For example the manual lockout (NL160ago) is shown as forwarded to a group control unit, and the output (160-BLOC) shown is the confirmation of the status of the block valves closed and bleed valve open as is

5   forwarded to a group control unit.

The basic control unit C will also comprise (b5) means to execute said required action according to a logic or sequence according to which the basic control unit operates. For example the bleed valve (XV-162) is to

10   be confirmed closed before both blocks (XV-161/163) have permission to open. And the downstream block valve (XV-163) has delay to open (Delay Unit T05) to provide for pre-pressurisation (back-flow prevention). And downstream block valve (XV-163) is to be confirmed closed

15   before the bleed is allowed to open.

Optionally a basic control unit will also comprise (b6) means to alarm (Speaker) and (b7) means to indicate the effect of the controlled action. For example the controlled action is to open a valve and supply nitrogen

20   to a feed line. Means (b7) will indicate whether the valves (XV-161/163) are actually open and the bleed valve (XV-162) closed and nitrogen is actually being supplied as requested.

The basic control unit as shown in Figure 2 has

25   advantageously an alarm handling, i.e. when at alarm status the request to run is terminated the alarm is conveniently terminated as well.

The basic control unit as shown in Figure 2 will provide the operator easy access to individual modules,

30   and contains autonomous local valve function validation by means of indicators (I-10 as shown for valve XV-161) and alarm.

Figure 3 shows how one group control unit (100) and a number of basic control units (A, C, E, H) control the gasifier start and stop sequencing. The group control unit is the Start-up/shutdown sequence control unit (100). The basic control units are the natural gas feed control (E; Figure 1), the oxygen feed control (A in Figure 1) and the low pressure purge feed control (C in Figure 1) and the effluent/syngas routing control unit (H). For clarity reasons some basic control units are not shown in Figure 3, such as controls B and F of Figure 1.

The Start-up/shutdown sequence control unit (100) acts as the operator interface for the fully automated sequenced start-up and shut down of the gasification in the reactor (2). This may be performed controlled (via Distributed Control System) and safeguarded (via Emergency Shut Down system). Basically the group control unit (100) controls that a sequence of actions is performed while checking if the correct feed is fed to the burner before proceeding to the next action. If the feedback regarding the correct feed and valve positions (Other permits) is not received by unit (100) within a required time control unit (100) aborts the start-up sequence and starts the shut down sequence.

In figure 3 the following acronyms have the following meaning:

PDT= pressure differential transmitter

GBS= proximity limit switch from valve

HZ= manual lock out

R= manual reset

HS= manual request selection

XT= instrument signal transmitter

FT= flow instrument signal transmitter

ESD= emergency shut down

TT= temperature instrument signal transmitter

PT= pressure instrument signal transmitter

In Figure 3 it is shown that Group control unit (100) is provided with (g1) means to receive and priority

5 handle a start/stop request (104). Group control unit (100) is further provided with (g2) means to receive and transform information from the process and/or from basic control unit(s) (e.g. Unit E and A in Figure 3) and/or from group control unit(s) into a permit required to

10 start (101-103) or to continue (107-110) to execute said group actions.

Group control unit (100) further provided with (g3) means to receive lockouts from basic control unit(s) (105) and/or from group control unit(s) and/or from the

15 operator (HZ or ESD) and/or from the group control unit itself (122) to prevent the start or to initiate the termination of said action and force the default status or shut-down sequence of the group control unit until the received lockout(s) has (have) been removed and also a

20 reset (R) has been activated.

Group control unit (100) further provided with (g4) means (111) to process an internal lockout (122) and/or export an output or lockout (121), which output/lockout is related to the status of said group action and (g5)

25 means (110) to execute said required group action according to a logic or sequence according to which the group control unit operates to control the basic control units via (112)-(120).

Basic control unit (E) is provided with (b1) means to

30 receive and priority handle a remote request (112) for a basic control action from the group control unit or from the operator (HS) to be performed by said basic control unit, (b2) means to receive and transform information

from the process (PDT, GBS) and/or output from basic
control unit(s) and/or output from group control unit(s)
into a permit required to start or to continue to execute
said action (142), (b3) means to receive lockouts (139)
from the group control unit and/or from the operator (HZ)
and/or from the basic control unit itself (see for
example control unit A and reference number 107) to
prevent the start or to initiate the termination of said
action and force the default status or shut-down sequence
(142) of the basic control unit E until the received
lockout(s) (139, HZ) has (have) been removed and also
reset (R) has been activated, (b4) means (143 or 154 for
unit A) to process an internal lockout and/or export an
output or lockout(147), which output/lockout is related
to the status of said action and (b5) means to execute
said required action according to a logic or sequence
(142) according to which the basic control unit operates.

Basic control unit (A), (G) and (H) as shown in
Figure 3 have the same functionalities as basic control
unit (E) described above, wherein the reference numbers
used refer to the following functions/actions:

Run permit (149), Lockout reset (150), Request
selection (151), Valve sequence processor (153), Process
evaluation and response delays (154), Enable DCS flow
control (155), Double block and bleed valves (156), Run
effective O2 (157), Run alarm O2 (107), Run permit (159),
Stack permit (123), Lockout reset (125), Request syngas
to flare (127), Request syngas to scrubber (128), Valve
sequence processor (129), Priority selection (130),
Enable DCS pressure control on valve (131), DCS
enable/disable valves (132), Run effective to flare
(133), Run alarm to flare (134), Run effective to stack

(135), Run alarm to stack (136) and run effective to scrubber (137).

The status of a basic control unit (C) (NITROGEN PURGE TO OXYGEN LINE) may suitably be provided to an operator via a screen. By means of indicators (201-210) on a computer screen dedicated to a single basic control unit the operator will be provided with information about the valve positions, requests, lockouts etc. in an easy to understand manner.

Applicants found that when the above safeguarding and control scheme is applied especially to a gasification process safety and reliability of the process is improved. Further, more operator tasks can be handled by the safeguarding and control scheme than practical in the past. It appears that the on-stream time can be improved in a cost effective manner while avoiding trips of a non-safe nature. The scheme also makes the complex system of control and safeguarding more transparent. Furthermore a high degree of automation can be achieved during start-up, shut down and operation.

C L A I M S

1. Method to control a process, wherein the status of
the process can be altered by a multitude of actions,
wherein the action is controlled by basic control units,
wherein at least one basic control unit is coordinated by
5   at least one group control unit and wherein this basic
control unit comprises the following functions:
(b1) means to receive and priority handle a request for a
basic control action from one or more group control units
or from the operator to be performed by said basic
10   control unit, (b2) means to receive and transform
information from the process and/or output from basic
control unit(s) and/or output from group control unit(s)
into a permit required to start or to continue to execute
said action, (b3) means to receive lockouts from basic
15   control unit(s) and/or from group control unit(s) and/or
from the operator and/or from the basic control unit
itself to prevent the start or to initiate the
termination of said action and force the default status
or shut-down sequence of the basic control unit until the
20   received lockout(s) has (have) been removed and also a
reset has been activated, (b4) means to process an
internal lockout and/or export an output or lockout,
which output/lockout is related to the status of said
action and (b5) means to execute said required action
25   according to a logic or sequence according to which the
basic control unit operates,
and wherein at least one of these group control unit
comprises the following functions:

(g1) means to receive and priority handle a request for a group control action from an even higher hierarchy control unit or from the operator to be performed by said group control unit, (g2) means to receive and transform

5   information from the process and/or from basic control unit(s) and/or from group control unit(s) into a permit required to start or to continue to execute said group action, (g3) means to receive lockouts from basic control unit(s) and/or from group control unit(s) and/or from the

10   operator and/or from the group control unit itself to prevent the start or to initiate the termination of said action and force the default status or shut-down sequence of the group control unit until the received lockout(s) has (have) been removed and also a reset has been

15   activated, (g4) means to process an internal lockout and/or export an output or lockout, which output/lockout is related to the status of said group action and (g5) means to execute said required group action according to a logic or sequence according to which the group control

20   unit operates.

2. Method according to claim 1, wherein at least one basic control unit is coordinated by at least two different group control units.

3. Method according to any one of claims 1-2, wherein

25   the basic control action is controlling Single Blocks or sequence controlling Double Block with Bleed (DBB), enabling/disabling control valves for Distributed Control System (DCS) functions or sequences controller actions.

4. Method according to any one of claims 1-3, wherein

30   the basic control unit will also comprise means to alarm (b6).

5. Method according to claim 4, wherein the basic control unit will also comprise an alarm handling

procedure such an alarm is terminated when the request to
run (b1) is terminated.

6. Method according to any one of claims 1-5, wherein
the basic control unit will also comprise means (b7) to

5   indicate the effect of the controlled action.

7. Method according to any one of claims 1-6, wherein
the operator will have access to the status of a basic
control unit and wherein the status will also provide
information directed to autonomous local valve function

10   validation by means of indicators.

8. Method according to any one of claims 1-7, wherein
the controlled process is a gasification process in which
synthesis gas is prepared by partial oxidation of a
solid, liquid or gaseous (hydro) carbon containing feed.

15   9. Method according to claim 8, wherein a group control
unit coordinates the start up and shut down sequence
control with basic control units which control a (hydro)
carbon feed, an oxygen feed, a purge feed and a
(synthesis) gas routing.

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METHOD TO CONTROL A PROCESS   05. 04. 2002

(65)

Method to control a process, wherein the status of
the process can be altered by a multitude of actions,
wherein the action is controlled by basic control units,
wherein at least one basic control unit is coordinated by
at least one group control unit and wherein this basic
control unit comprises the following functions:
(b1) means to receive and priority handle a request for a
basic control action from one or more group control units
or from the operator to be performed by said basic
control unit, (b2) means to receive and transform
information from the process and/or output from basic
control unit(s) and/or output from group control unit(s)
into a permit required to start or to continue to execute
said action, (b3) means to receive lockouts from basic
control unit(s) and/or from group control unit(s) and/or
from the operator and/or from the basic control unit
itself to prevent the start or to initiate the
termination of said action and force the default status
or shut-down sequence of the basic control unit until the
received lockout(s) has (have) been removed and also a
reset has been activated, (b4) means to process an
internal lockout and/or export an output or lockout,
which output/lockout is related to the status of said
action and (b5) means to execute said required action
according to a logic or sequence according to which the
basic control unit operates,

and wherein at least one of these group control unit
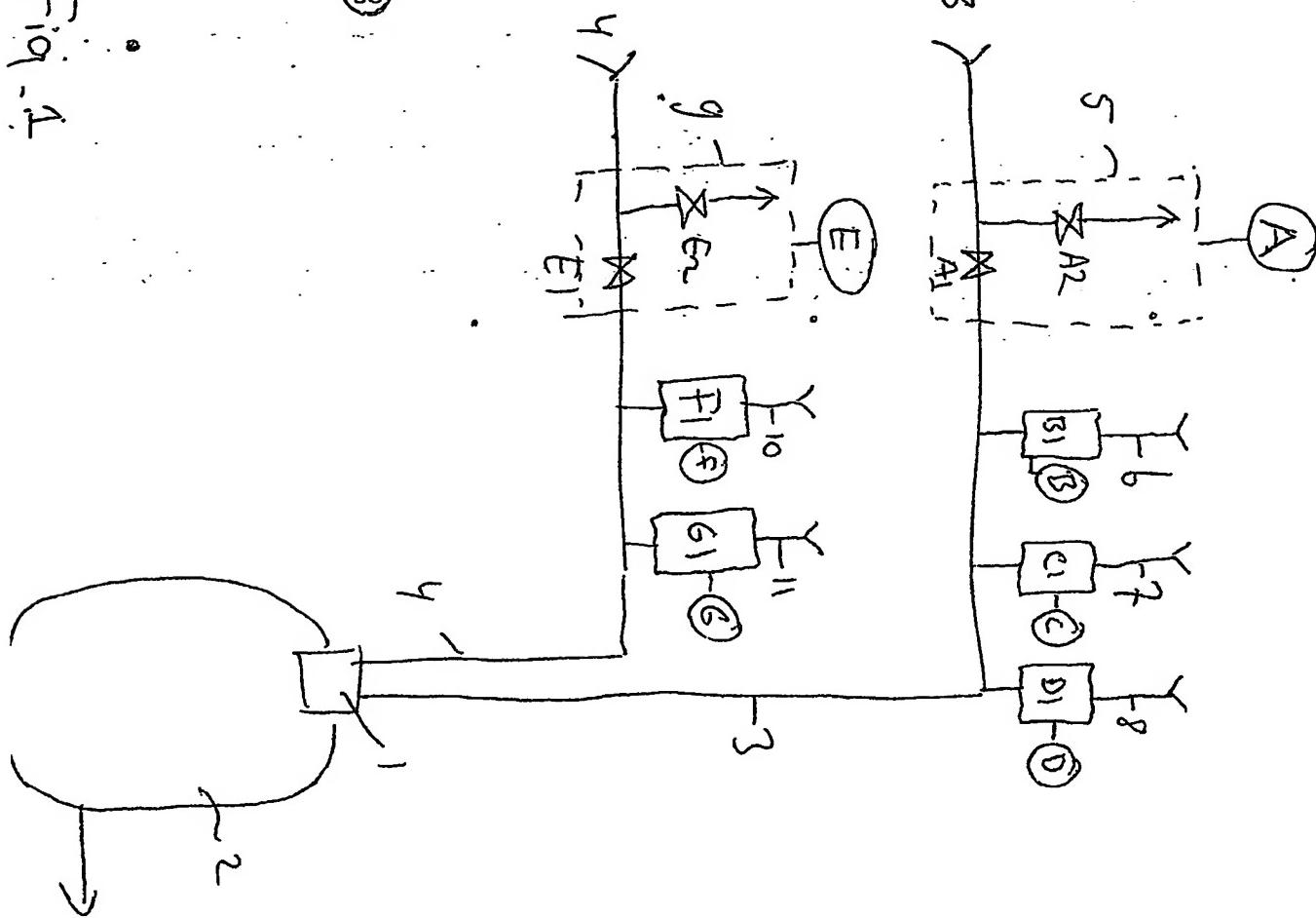comprises the following functions:

(g1) means to receive and priority handle a request for a
group control action from an even higher hierarchy
control unit or from the operator to be performed by said
group control unit, (g2) means to receive and transform
information from the process and/or from basic control
unit(s) and/or from group control unit(s) into a permit
required to start or to continue to execute said group
action, (g3) means to receive lockouts from basic control
unit(s) and/or from group control unit(s) and/or from the
operator and/or from the group control unit itself to
prevent the start or to initiate the termination of said
action and force the default status or shut-down sequence
of the group control unit until the received lockout(s)
has (have) been removed and also a reset has been
activated, (g4) means to process an internal lockout
and/or export an output or lockout, which output/lockout
is related to the status of said group action and (g5)
means to execute said required group action according to
a logic or sequence according to which the group control
unit operates.

Fig. 1

LP-NITROGEN PURGE TO OXYGEN LINE